3.2 GEOLOGY AND SOILS

Geologic and soil resources relevant to the Proposed Action and its alternatives include soils, sediment deposits in the Mississippi Sound and Back Bay, and extractable mineral resources. This section analyzes these resources across an ROI that includes the sites of the Proposed Action and its alternatives, including areas that would be subject to dredge and fill activities. Soils of the three-county region are also analyzed for their impact on septic tank use. Soil, sediment, and geologic characteristics are determined by a review of available literature, previous investigations, and site audits.

3.2.1 Soils

This section focuses on the characteristics of soils in the three-county region and at the sites of the Proposed Action and its alternatives. Steepness of slope, texture, and permeability affect the likelihood that soils will erode and wash into surface waters during storm events. Improperly managed construction sites are particularly prone to such erosion. Soil type and texture are also critical to the effectiveness of septic systems. Unsuitable soil characteristics interfere with proper septic operation, increasing the flow of nutrients and pollutants to surface waters. Section 4.3 further evaluates the impacts of septic tank use.

3.2.1.1 General Soil Characteristics

There are two physiographic divisions in Harrison County (USDA, 1975). The Gulf Coast Flatwoods form an irregular belt along the southern boundary of the county. This strip of lowland consists of a series of wet, poorly drained depressions with some higher, better drained areas. The Southern Lower Coastal Plain is the rolling, gently undulating upland area of the interior. The general slope of the county is to the south. Elevations vary considerably, from 90 feet above sea level in the northern part of Harrison County to 24 feet at Biloxi. The county's flatter slope generally restricts drainage.

Overall, the soils in Harrison, Hancock, and Jackson Counties are poorly suited for safe on-site disposal of wastewater (i.e., septic systems). Table 3.2-1 shows the percentage and acreage of soils within each of the three coastal counties rated as unsuitable, marginal, or suitable for underground absorption. An unsuitable rating indicates soil characteristics that do not allow for the adequate treatment of septic tank effluent. These characteristics commonly include soil saturation, high clay content, and the presence of an impeding layer. Marginal soils are just within the limits of acceptable soil absorption capabilities. Suitable soils have characteristics that can effectively treat septic waste.

Table 3.2-1
Soil Suitability for Septic Use in Coastal Counties

County	Unsuitable		Marginal		Suitable	
	Acres	Percent	Acres	Percent	Acres	Percent
Hancock	156,027	50.3	128,804	41.5	25,569	8.2
Harrison	120,720	32.2	104,344	27.9	149,464	39.9
Jackson	274,423	57.6	39,517	8.3	162,220	34.1

Source: Hollomon, 1998.

Harrison County has a relatively even distribution of suitable, unsuitable, and marginal soils (Hollomon, 1998). In general, soils unsuitable for septic use in Harrison County occur along waterways. The northern half of Hancock County consists mainly of marginal soils, which could be effective in treating wastes from septic systems. The southern half of Hancock County, however, primarily contains soils unsuitable for proper septic operation (Hollomon, 1998). In Jackson County, areas of rapid growth and relatively high housing densities, such as Vancleave and other east-central parts of the county, contain some unsuitable soils (Hollomon, 1998).

3.2.1.2 Soils at Alternative Sites

Table 3.2-2 identifies major soil types at the sites of the Proposed Action and its alternatives. Characteristics such as drainage, permeability, slope, depth of water table, and corrosivity to steel or concrete could affect site runoff and erosion, as well as the suitability of soils for structural materials or foundations. It should be noted that these sites have been previously developed, and soil conditions have most likely been altered since the Soil Survey for Harrison County was published in 1975.

Table 3.2-2
Soils at the Broadwater and Alternative 3 Sites

Site	Major Soil Types
Broadwater (Alternatives 2, 4, and 5)	Sulfaquepts Harleston fine sandy loam, 0 to 2% slopes Harleston fine sandy loam, 2 to 5% slopes Lakeland fine sandy loam Latonia loamy sand Ponzer and Smithton soils Plummer loamy sand
Alternative 3: A	Sulfaquepts
Alternative 3: B	Harleston fine sandy loam, 2 to 5% slopes
Alternative 3: C	Sulfaquepts
Alternative 3: D	Sulfaquepts
Alternative 3: E	Harleston fine sandy loam, 2 to 5% slopes Handsboro series
Alternative 3: F	Harleston fine sandy loam, 2 to 5% slopes

Source: USDA, 1975.

Broadwater Site

The marina portion of the Broadwater site consists of Sulfaquepts, which are formed in areas of hydraulic fill pumped or dredged from the bays or the Mississippi Sound. Sulfaquepts are predominantly sands with nearly level slopes. The water table is high and permeability is rapid. These soils are extremely corrosive because of high acidity. These soils are most suited for roads, parking areas, and structures without basements.

The area just north of US 90 is predominantly Lakeland fine sandy loam. These soils are excessively drained and have rapid permeability, producing little or no runoff. Slope stability is poor, and corrosivity is low to moderate.

The golf course is primarily Harleston fine sandy loam, with two to five percent slopes. These soils are moderately well drained with moderate permeability and slow to moderate runoff. Slopes have fair stability, and corrosivity is moderate to high. Soils are subject to erosion if left unprotected.

Alternative 3

The two major soil types at the Alternative 3 sites are Sulfaquepts and Harleston fine sandy loam, with two to five percent slopes (described above). There is also evidence that much of Site A was filled with oyster shells during its previous use as a seafood factory. The possible presence of oyster shell fill, however, does not represent a significant environmental condition. In the southern portion of the tract, Site E has some Handsboro series soils. These nearly level soils are very poorly drained with moderate permeability and are subject to daily tidal flooding. Areas of this soil association are generally important to the saltwater estuarine system.

3.2.2 Sediments

This section describes the characteristics of sediments from the bottom of the Mississippi Sound and Back Bay that would be subject to dredge and fill activities under the Proposed Action and its alternatives. As discussed in Section 4.3, the physical and chemical characteristics of sediment affect the potential water quality impacts of dredging operations and the suitability of excess spoil for disposal.

3.2.2.1 Sediment Characteristics in the Mississippi Sound and at the Broadwater Site

Chemical pollutants are generally associated with fine-grained sediment particles rather than with coarse grained sands (Lytle and Lytle, 1998). Fine-grained sediments are more easily disturbed during rain events and can be transported farther by runoff from their original source. After the particles settle, chemical pollutants usually remain associated with fine-grained sediments for long periods of time. Since circulation patterns in the Mississippi Sound tend to be sluggish, most sediment loads coming down coastal rivers and into the bays settle out before reaching the Sound. Fine-grained particles, therefore, tend to accumulate in regions of bays and bayous where the tides and currents are more limited. In contrast, areas with strong currents and erosion activity, such as the coastal shoreline, have less fine-grained sediment and a higher percentage of coarser grained sands.

Overall, Mississippi Sound sediments are reported to have limited areas with high sediment contamination levels. Based on EMAP-E sampling data from 1991 to 1994, EPA (1999) estimates that six percent of the Mississippi Sound area exhibits high sediment contaminants. This compares to area estimates for neighboring northern Gulf estuaries, such as Mobile Bay (61 percent), Perdido Bay (92 percent), and Pensacola Bay (62 percent). Table 3.2-3 summarizes sediment contaminant concentrations from the EPA EMAP-E database in the Mississippi Sound, sampled between 1992 and 1994.

Table 3.2-3
Sediment Contaminant Concentrations of the Mississippi Sound

Contaminant Types	Levels of Concentration[1]		
	1992	1993	1994
Metals (mg/kg dw)			
Aluminum	76 - 89,200	3,930 - 94,400	600 - 84,000
Antimony	.07 - .94	nd - .7	nd - .59
Arsenic	.08 - 13.5	1.08 - 19.5	nd - 16.8
Cadmium	nd - .14	nd - .14	nd - .18
Chromium	nd - 95.5	4.9 –105	.10 - 72.5
Copper	.20 - 30.4	1.1 - 22.1	.30 - 16.6
Iron	nd - 51,700	1,790 - 51,300	300 - 39,500
Lead	.30 - 24.5	3.0 - 26.6	.70 - 30
Mercury	.003 - .105	.016 - .118	nd - .094
Nickel	.15 - 34.3	1.5 - 31.8	2.3 - 25.8
Selenium	.02 - .56	nd - .64	nd - .54
Silver	.01 - .10	.03 - .14	.01 - .12
Tin	nd - 3.06	.12 - 1.71	.04 - 3.25
Zinc	nd - 118	12 – 160	1.9 - 105
Total PAHs (ug/kg dw)	249 - 3,200	5.5 – 195	nd - 263
Total PCBs (ug/kg dw)	.028 - 4.74	.30 - 1.48	nd - 2.79

Source: EPA, 1999e.
Notes:
[1]Range of values for five stations (1992), six stations (1993), and six stations (1994) sampled in Mississippi Sound.
nd - denotes non-detected.
mg/kg dw - milligrams per kilogram dry weight (ppm).
ug/kg dw - micrograms per kilogram dry weight (ppb).
PAHs - polycyclic aromatic hydrocarbons.
PCBs - polychlorinated biphenyls.

Sediment quality investigations at the Broadwater site include two sampling events. In 1994, surface sediments were sampled from the existing Broadwater marina basin and entrance channel in connection with a proposed maintenance dredging activity (Thompson Engineering, 1994). In 1998, sampling activities for the Proposed Action included chemical characterization of sediments from an approximate elevation of minus-12 feet mean low water (mlw), equivalent to the proposed dredging depth, at ten specified boring locations in the entrance channel and proposed casino/hotel development area (Thompson Engineering, 1998).

In 1994, grab samples of surface sediments from six entrance channel locations were formed and labeled CS-01. A composite of four surface sediment grabs from within the existing marina basin was labeled CS-02. In 1998, the ten boring locations were designated B-1 through B-10. Borings B-1 through B-3 were in the existing entrance channel from its southernmost limit to near the current marina entrance (coincident with the proposed western breakwater of the casino/hotel development area). Borings B-4 through B-7 were south of the existing marina and east of the current entrance channel, and within the central portions of the proposed casino/hotel development area. Borings B-9 and B-10 were on land in the southernmost parking area of the existing marina, and boring B-8 was in water east of that area. Borings B-8 through B-10 were in the northern portion of the proposed casino/hotel development area.

Sediment characterization included physical (textural classification) and "bulk" (total concentration) analyses of a broad range of inorganic and organic contaminants. Additionally, elutriate analyses were performed, using a standardized procedure applicable to dredged material evaluations that simulates the potential release of contaminants from sediments to the water column. Elutriate is a suspension prepared by mixing specific volumes of sediment and water. The mixture is then used for chemical analysis and toxicity testing. Section 4.3 discusses the results of the elutriate analyses.

Table 3.2-4 summarizes the results of bulk (total concentration) sediment analyses measured on the samples collected from the Broadwater site in 1994 and 1998. Sediment chemical data cannot be used for direct standards compliance evaluation, because no federal or state sediment quality standards have been established.

Table 3.2-4
Summary of Bulk (Total Concentration) Sediment Chemistry Results for Selected Parameters at the Broadwater Site

	1994		1998	
	CS-01	CS-02	B-1, B-2, B-3 (Range)	B-4 thru B-10 (Range)
Textural Classification	Sandy Clay	Clay	Clays	Sands
TOC, mg/kg dw	6,000	7,400	12,000 - 23,000	850 - 6,000
Ammonia-N, mg/kg dw	24	230	200 - 550	<.25 - 2.9
Metals (mg/kg dw)				
Aluminum	-	-	14,000 - 31,000	400 - 2,200
Arsenic	6.4	9.7	3.4 - 4.3	.017 - 1.6
Antimony	<5	<5	.53* - 1.0*	<.42 - .49
Barium	—	—	20 - 35	.92* - 4.8
Beryllium	1.1	1.2	.78 - 1.3	.099* - .29
Cadmium	<.5	<.5	<3.9**	<.056 - <.39**
Chromium	31	28	17 - 30	1.2 - 2.9
Copper	7.3	81	10 - 12	.52* - 1.6*
Iron	—	—	16,000 - 31,000	740 - 2,300
Lead	11	26	15 - 23	.84 - 2.0
Manganese	—	—	990 - 1,200	12 - 35
Mercury	.034	.057	.034 - .075	<.0024 - .012*
Nickel	14	17	8.4 - 17	<1.1 - 2.3*
Selenium	<.1	.10	<.46	<.46
Silver	<.5	<.5	<.5**	<.063 - .29*
Thallium	<1	<1	.9* - 1.6	<.46
Vanadium	—	—	24 - 45	1.2 - 5.3
Zinc	59	141	72 - 78	6.7 - 39
Total VOCs, ug/kg dw	—	—	nd - 56	4.6 - 19
Total PAHs, ug/kg dw	nd	nd	nd - 322	nd
Total PCBs, ug/kg dw	nd	nd	nd - 4.5	nd - 14

Source: Thompson Engineering, 1994 and Thompson Engineering, 1998.
Notes:
— - denotes analysis not performed.
* - estimated concentration between target detection limit and practical quantitation limit.
** - elevated detection limit due to matrix interference.
nd - denotes non-detected.
mg/kg dw - milligrams per kilogram dry weight (ppm).
ug/kg dw - micrograms per kilogram dry weight (ppb).
VOCs – volatile organic compounds.
PAHs - polycyclic aromatic hydrocarbons.
PCBs - polychlorinated biphenyls.

3.2.2.2 Sediment Characteristics in the Lower Biloxi Bay

Sediment quality characteristics of the lower region of Biloxi Bay (i.e., below the I-110 bridge) show a wide variability of sediment contaminant concentrations. Table 3.2-5 presents the range of concentrations at seven stations sampled in 1992 between the I-110 bridge and the railroad bridge crossing Biloxi Bay. Also shown are data from a 1994 EMAP-E station near the mouth of the Bay, and a NOAA National Status and Trends (NS&T) station sampled in 1986 and 1987, near Point Cadet.

Table 3.2-5
Sediment Contaminant Concentrations of Lower Biloxi Bay

	USM-GCRL, 1992[1]	EMAP-E, 1994[2]	NOAA NS&T, 1986-1987[3]
Metals (mg/kg dw)			
Aluminum	6,000 - 25,000*	68,700 - 81,400	4,500 - 66,500
Arsenic	nd - 11.7	11.70 - 21.20	1 - 12
Cadmium	nd - 1.10	.18 - .26	nd
Chromium	nd - 110	62.30 - 70	nd - 76
Copper	1.80 - 14.8	15.50 - 16.30	2 -25
Iron	12,000 - 20,000*	33,000 - 38,500	2,000 - 32,500
Lead	.90 -35.8	22.0 - 31.10	6.0 - 65
Mercury	.009 -.277	.08 - .102	ND
Nickel	1.40 - 29.50	20.60 - 24.80	1.0 - 21
Selenium	nd - 3.20	.34 - .82	nd - 1.0
Silver	nd - 15.33	.10 - .17	ND
Tin	nd - 1.56	2.63 - 3.93	1.0 - 4.0
Zinc	21.40 - 86.10	96.80 - 107	18 - 123
Total PAHs (ug/kg dw)	500 - 4,900	124- 315	167 -6,300
Total PCBs (ug/kg dw)	-	1.71 - 1.80	9 - 21

Notes:
[1]Range of seven stations (21, 34, 37, 40, 48, 59, 60) between I-110 and the railroad bridge crossing lower Biloxi Bay.
[2]EMAP-E stations LA94SP14 and LA94SR14 near mouth of Biloxi Bay [EPA, 1999e].
[3]NOAA National Status and Trends (NS& T), Mussel Watch Program, Station MSBB near Point Cadet.
nd - denotes non-detected.
mg/kg dw - milligrams per kilogram dry weight (ppm).
ug/kg dw - micrograms per kilogram dry weight (ppb).

The NOAA NS&T station demonstrates the variability that could occur in sediment contaminant concentration levels, even from the same general location. Although such variability could be temporal, it more likely reflects spatial differences and the proportion of fine-grained sediments (silts/clays) in the sample. In 1986, the NOAA NS&T samples (which have lower contaminant concentrations) had fine-grained fractions less than 6.2 percent, whereas in 1987 the fractions of fine-grained sediments were as high as 92 percent. The sediment polynuclear aromatic hydrocarbon levels (PAHs) from the NOAA NS&T station in Biloxi Bay (Station MSBB) are considered high when compared statistically to the nationwide NS&T database (greater than one standard deviation above the geometric mean, or roughly in the upper 15 percent of all data).

Based on studies in the 1980s targeting hydrocarbons as a major pollutant source, Lytle and Lytle (1998) characterized the potential impacts of pollutants throughout the Mississippi Sound and its river and bay systems. The studies, using an "Environmental Stress Index" that reflects several factors related to sediment characteristics and toxicity, developed spatial comparisons within the estuary. Generally, the Biloxi Bay System was characterized as less polluted than the Pascagoula System, but significantly higher than the Open Sound System. The lower Biloxi Bay region falls within the low to moderate range of the index.

Overall, based on available data, contaminant characteristics for sediments in the lower Biloxi Bay do not appear to differ significantly from the characteristics of sediments at the Broadwater site. The variability associated with sediments in the lower Biloxi Bay area suggests that site-specific evaluations of sediment quality would be warranted for dredging actions in the Back Bay. Such evaluations would need to be conducted in accordance with the Inland Testing Manual (EPA/USACE, 1998) or the Ocean Disposal Testing Manual (EPA/USACE, 1991) depending on the disposal site. In either case, the dredged material disposal would not be permitted unless the sediments proved to be suitable.

3.2.3 Extractable Mineral Resources

Geologic features are used to assess the distribution and availability of energy, mineral, and groundwater resources. Section 3.4 analyzes the quality and quantity of groundwater in the coastal area. This section focuses on the presence of energy and mineral deposits in the three-county region.

Hancock, Harrison, and Jackson Counties are part of the Coastal Plain Region, which is a low broad plain (personal communication, K. Schmid, MDEQ, Jackson, MS to E. Drake, EDAW, Atlanta, GA, October 22, 1999). Surface units are mainly Pliocene and Pleistocene age sandy alluvium sediments. Alluvium is soil material, such as sand or clay, that has been deposited on land by streams.

The main geologic units underlying the region are (from oldest to youngest): the Catahoula Formation, which is about 2,900 to 3,600 feet deep; the Hattiesburg Formation; and the Pascagoula Formation, which is between 680 and 2,300 feet (personal communication, K. Schmid, MDEQ, Jackson, MS to E. Drake, EDAW, Atlanta, GA, October 22, 1999). The Citronelle Formation is a near surface unit of gravelly sand and clayey sand layers and lenses that is approximately 30 to 80 feet thick. Gravel is more abundant to the north.

The state's surface mines produce sand, gravel, clay, bentonite, chalk, and limestone. According to the USGS, the 1998 estimated value of non-fuel mineral production in Mississippi was $190 million (USGS, 1998). Construction sand and gravel are the leading nonfuel mineral resources, accounting for almost 39 percent of the state's value in 1998. Portland cement and fuller's earth followed respectively as the second and third leading mineral commodities. Mississippi's production value has risen since 1996, primarily because of an increase in construction sand and gravel mining. Based on USGS estimates of minerals produced in 1998, Mississippi ranked second among the 50 states in the production of fuller's earth and fourth in ball clay bentonite.

The Mining and Reclamation Division (MRD) of the Office of Geology regulates all surface mining in the state. MRD has issued 75 permits for surface mine operations in the three-county region (personal communication K. McCarley, Geologist/Director, Mining and Reclamation Division, Jackson, MS to E. Drake, EDAW, Atlanta, GA, September 24, 1999). These mines primarily produce fill dirt, sand, clay, and gravel. None of the surface mines is near the Broadwater or Alternative 3 sites.

The Mississippi State Oil and Gas Board regulates all oil and gas drilling, production, and storage in the state. As of 1998, there were approximately 24 oil- and/or gas-producing wells in three active fields onshore in Hancock County: the Catahoula Creek Field; the Ansley Field; and the Waveland Field (personal communication, K. Schmid, MDEQ, Jackson, MS to E. Drake, EDAW, Atlanta, GA, October 22, 1999). The Oil & Gas Board reported total 1998 production of 11,588 barrels of oil, 1,104,810 metric cubic feet (mcf) of gas, and 43,537 barrels of water at these fields. None of the active fields is near the Broadwater or Alternative 3 sites.

Mississippi's offshore waters and the three-county coastal region could possibly contain additional oil and gas reserves. There are several active exploration and production fields in areas adjacent to the three-county coastal region and state waters. Given the significant depth of two of these trends combined with the expense of offshore drilling and low petroleum prices, no new exploration drilling has occurred recently. Recent requests for information regarding leasing of the state's offshore minerals, however, indicate interest in state waters. To the east, the shallow Miocene Gas field is productive in adjacent onshore Alabama, Alabama state waters, and federal offshore waters. Additionally, the deep Norphlet Gas field is productive in the same areas and immediately south of Petit Bois Island in adjacent federal offshore waters approximately 30 miles south-southeast of Biloxi. A third productive gas field is developing in the federal Outer Continental Shelf (OCS) waters. Five different gas discoveries have been made in the Mobile and Viosca Knoll OCS areas of federal offshore waters. The current trend appears to indicate that gas reserves in the James Lime filed may be present in the central part of Mississippi's state waters offshore and extend onshore in the Gulfport/Biloxi area and inland through Hancock and Harrison Counties.

As of September 20, 1999, the Oil and Gas Board issued no new drilling permits in Hancock, Harrison, or Jackson Counties. Currently, there are no active oil and gas leases of state minerals in Mississippi state waters offshore (personal communication, K. Schmid, MDEQ, Jackson, MS to E. Drake, EDAW, Atlanta, GA, October 22, 1999). A permit to collect seismic data in state waters, however, has been issued.